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The Coastal Engineering Research Center's Field Reseach Facility at Duck, North Carolina

By Curtis Mason
Coastal Engineering Research Center
Fort Belvoir, Virginia

INTRODUCTION

In August, 1977, construction of the 1800 foot long pier shown in Figure 1 was completed on the Outer Banks of North Carolina, 15 years after the concept of a coastal field research facility was orginally proposed. This paper discusses the purpose of this effort; the physical characteristics of the site; the status of the facility; and related data collection, analysis and display capabilities. Scientific projects underway and planned for the facility are also discussed.

Much of the Coastal Engineering Research Center's past coastal engineering research has been laboratory experimentation and theoretical investigations. Supportive field work has been hampered by the lack of a dependable means of obtaining high-quality wave, beach, and water level data, including data during storms. Therefore, the CERC Field Research Facility has been designed to fulfill four major objectives:

a. To provide a rigid platform from the land, across the dunes, beach, and surf zone, to the 25 foot water depth, from which waves, currents, water levels, and bottom elevations can be measured, especially during severe storms.
b. To serve as a permanent field base of operations for physical and biological studies of the site, the adjacent sound, and nearby islands, bays and ocean regions, by CERC and other agencies and universities.
c. To provide CERC with field experience and data that will complement laboratory and analytical studies, and provide a better understanding of the influence of field conditions on measurements and design practices.
d. To provide a manned field facility for testing of new instrumentation.

SITE DESCRIPTION

The Field Research Facility site one mile north of Duck, North Carolina lies on the northern end of Bodie Island between Currituck Sound and the Atlantic Ocean (See Fig. 2). The property borders 3300 ft of Atlantic Ocean on the east and Currituck Sound on the west, and is about 2400 feet wide.

The following physical characteristics of the site were found to meet essential site selection criteria better than other sites evaluated:

1. Sand size. Sand from the foreshore and surf zone in this region is quite coarse (median diameter about 0.75mm) and typically bimodal. Dune sands are finer, averaging about 0.3 mm median diameter. Offshore, sands decrease in median size from 0.75 mm at the surf zone to less than 0.1 mm at the 60-ft depth. Indications are that the surf and foreshore surficial sands form a wedge-shaped cross section which pinches out on top of finer sands just seaward of the surf zone. The composite thickness of alternating layers of 1 and 0.3 mm material on the foreshore is at least 6 feet. No consolidated subsurface strata were observed to crop out and none was indicated on well logs available from local developers.
2. Wave and Weather Conditions. A summary of weather features affecting Cape Hatteras, 65 miles south, indicates that the sky should be clear at Duck about 100 days per year, and that the annual rainfall of 55 inches will be evenly distributed throughout the year. Mean daily temperatures range from 78° during July and August to 53° in January and February. Mean monthly wind speeds of about 12 miles per hour prevail from the northeast be-

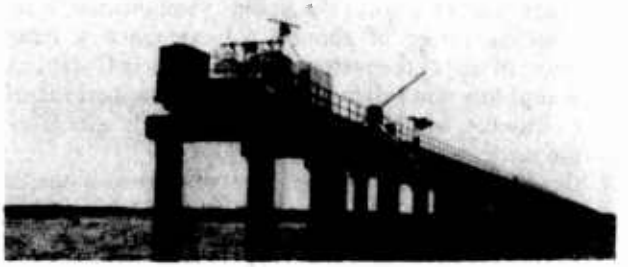

Fig. 1. CERC field research facility pier.

*Editor's note. This is the second of a series of articles on notable coastal engineering laboratories throughout the world. The first article appeared in Shore and Beach, October 1977.

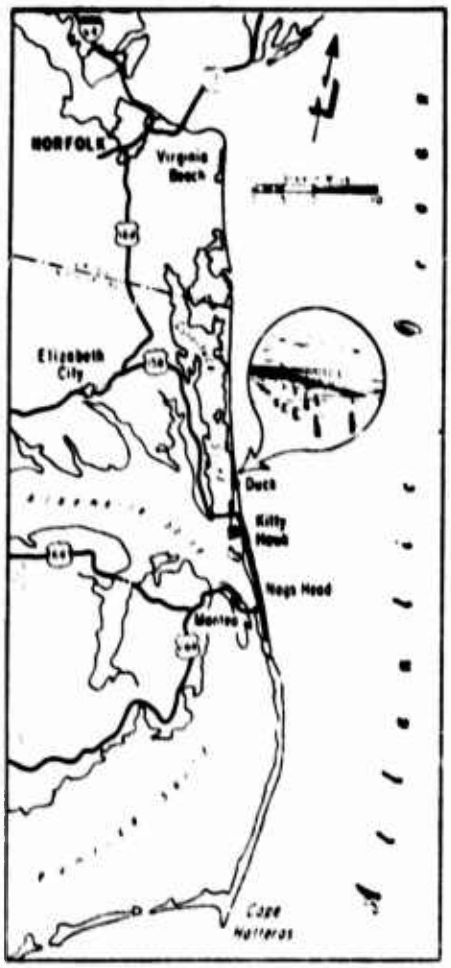

Fig. 2. Location map.

tween September and February, and from the southwest the remainder of the year. Because of this wind pattern, waves generally approach the Duck site from the northeast during the winter and from the east and southeast during the summer. Data from a wave gage at Nags Head, 13 miles south, show the mean annual significant wave height to be about 1 meter, with a standard deviation of 0.7 meters. The mean significant wave period is about 8 seconds, with a 2.5 second standard deviation. Longshore sediment transport rates are estimated to be about 1.5 million cubic yards per year southward, and about 750,000 cubic yards per year northward, for a 2:1 southward predominance, due primarily to the effects of winter storms (northeasters). Over the past 70 years, hurricanes have affected the area to some extent about once every two years.

3. Tides. Ocean tides at the site are semi-diurnal, with a spring range of about 1.5 meters and a neap range of about 0.7 meters. Water levels in Currituck Sound are wind-dominated: high during periods of southwest winds, and low when winds are from the northeast.
4. Beach and Shelf Slopes. The nearshore slope is reasonably typical of other U.S. coastal profiles, and the 20 ft contour is about 1000 ft from the mean sea level contour (Fig. 3).
5. Nearby Littoral Barriers. The coastline is relatively

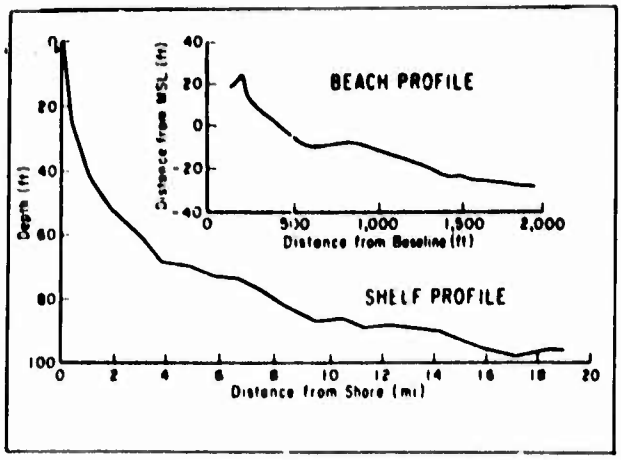

Fig. 3. Beach and shelf profiles.

straight, curving gently to the east south of the site, and with an indentation about 3.5 miles north at the location of a former inlet. No inlets or structures exist on the coast within 5 miles of the site.

6. Offshore bathymetry. Hydrographic charts show that no unusual offshore bottom features exist in the immediate vicinity of the pier, but that waves approaching from the northeast may be refracted by shoals near False Cape (Fig. 4).
7. Vehicular access. A paved state highway is connected to the site by a crushed gravel road.
8. Site Security. Although visitors are allowed at the site, public access to the pier is restricted. Ramps at the north and south edges of the property allow beach vehicles to transit from the beach, over the dunes and around the facility so that on-going beach studies will not be affected.

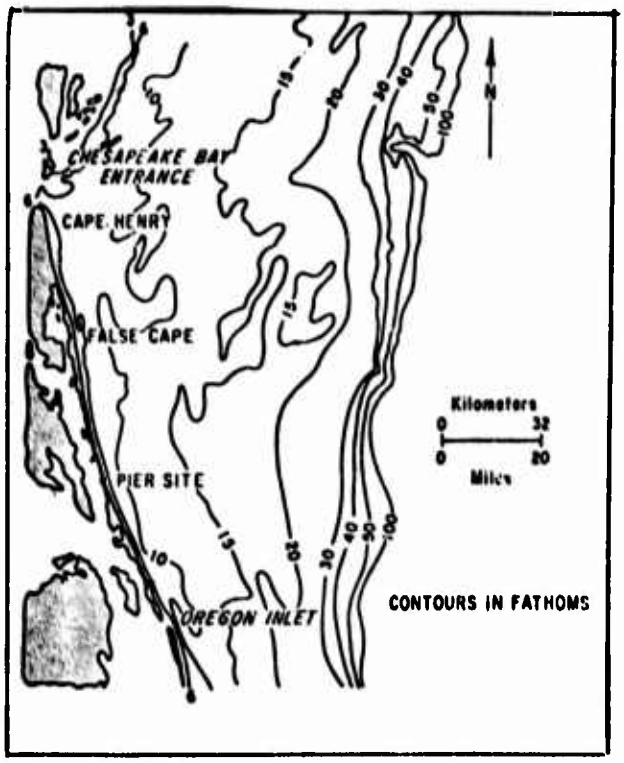

Fig. 4. Offshore bathymetry.

FACILITIES

The physical characteristics of the major structures of the Field Research Facility, the main building and the research pier, are as follows: The 4600-sq.-ft laboratory building of the Facility will have four rooms for data collection and preliminary analysis efforts, an instrument repair shop, a vehicle shelter, a diving locker, and a bunkroom for visiting scientists.

A platform for outside work and access to the pier will surround the building. The research pier is a reinforced concrete structure supported with 3 feet diameter steel piles spaced 40 ft apart along the pier length and 15 ft below the ocean bottom. The pier deck is 20 ft wide and extends 1840 ft from behind the dune line to about the 25-ft water depth. The deck is 25 ft above mean sea level. Concrete erosion collars protect the steel pilings against sand abrasion, and a cathodic protection system protects the steel pilings against corrosion. Railroad rails set 10 ft center to center run the full length of the pier and can support a 16-ton load. Electrical outlets are spaced in sets along the pier approximately 40 ft apart.

DATA COLLECTION

A basic environmental measurements program has been established to routinely measure, record, and publish data on the meteorological and oceanographic conditions at the site. Following data collection and editing, certain routine analyses are made. The data and results are made available to other CERC studies and to the scientific and engineering community upon request by the CERC Coastal Engineering Information and Analysis Center.

Meteorological data presently being collected include wind speed and direction, barometric pressure, accumulated precipitation, total solar radiation, and air temperature and relative humidity. Tide data are collected by National Ocean Survey (NOS) tide gages at the pier end and at about the 8-ft water depth. Paper tape is punched at six minute intervals giving the time and instantaneous water level reading. Daily ocean water temperature and salinity measurements are made at the seaward end of the pier, three feet above the bottom and six feet below MSL. To measure changes in the beaches and ocean bottom, weekly lead-line soundings on each side of the pier are being made, as are pre- and post-storm profiles. Quarterly surveys from behind the dunes to the −40 foot contour and extending a mile north and south of the pier are also conducted. Aerial photographs of the coastline from Cape Hatteras to Cape Henry, with a perpendicular flight at the Facility, are being flown quarterly and after major storms. Prior to pier construction, a topographic survey was made of the beaches and dunes, and a hydrographic survey was made of the adjacent ocean bottom. A beach profiling study was also initiated before pier construction, and these profiles continue to be monitored to assess the effect of the pier on the adjacent beaches. Baseline studies of the native flora and fauna of the island and nearshore zones have been made, and study results will be used to evaluate the ecological effects of pier construction and site habitation.

FRF RESEARCH PROGRAM

Research studies presently underway or planned for the next 3 years and those which are desirable are listed in Table 1 in groups corresponding to Corps of Engineers Coastal Engineering Research Subprograms. Desirable studies are those we feel should be done either by CERC at some later date, or sooner

TABLE 1.

FIELD RESEARCH FACILITY PROJECTS

Nearshore Wave Transformation Subprogram

- • **Ongoing or Planned in Next 3 Years**
- ◦ **Desirable**

Radar Wave Imaging •	Wave Runup •
Measurement of Wave Transformation •	Nearshore Current Regime •
Prediction of Wave Transformation •	Wave Reflection and Attenuation •
Wave Set up ◦	Long Period Waves ◦
Wave Transmission over Submarine Bars •	Wave/Current Interactions ◦
Wind Effects on Breaking Waves ◦	Edge Waves ◦

Nearshore Sediment Transport Subprogram

Methods for Measuring Longshore Sediment Transport •	Shoreline Response to Offshore Dredging •
Storm Erosion Studies •	Beach Profile Studies •
Guidelines for Nearshore Placement of Sediment •	Temperature Effects on Sediment Transport Rates ◦
Windblown Sediment Transport ◦	Barrier Island Migration ◦
Time Scale of Beach Response ◦	Sand Spit Development ◦
Response of Nearshore Bottom to Storms ◦	Evaluate Movable Bed Model Technology ◦
FRF Sediment Budget ◦	

Coastal Ecology

Assess Effects of Pier Construction on Flora and Fauna •	Vegetative Bank Erosion Control •

Remote Sensing

Evaluate Remote Sensing Techniques for Coastal Engineering •	SEASAT-A Evaluation •

Supplemental Studies

Basic Environmental Measurements Program •	Tidal Characteristics of Ocean & Sound ◦
Solar Radiation Characteristics ◦	Inlet Research Studies ◦
Wind Climatology	Sea/Air Interaction ◦
Physical Properties of Ocean and Sound Waters ◦	

by interested outside users. Although CERC funding limitations preclude direct support for these studies, we would endorse attempts by qualified investigators to obtain funding from other sources.

SUMMARY

The purpose and capabilities of the Field Research Facility have been reviewed, and the research program outlined. CERC encourages the use of the facility by outside investigators, for we feel it offers a unique opportunity to study coastal phenomena during both normal and storm conditions. If the proposed study is directly related to CERC objectives, use of the pier, environmental data, and limited support by on-site personnel are provided free of charge. Costs for extensive support and for projects not related to CERC objectives will be assessed at a rate dependent upon the degree of public interest served and the user's financial resources.

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Paper discusses the 1800-foot-long pier constructed in August 1977 at the CERC Field Research Facility (FRF), Duck North Carolina. The FRF was designed to fulfill major objectives in providing a permanent base for physical and biological study of coastal phenomena during normal and storm conditions; to provide CERC with field experience and data that will complement laboratory and analytical studies; and to provide a facility for testing new instrumentation.

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